(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) Publication number: **0 576 771 A1**

(12) EUROPEAN PATENT APPLICATION

(21) Application number: 92830321.3

(51) Int. Cl.5: E02B 3/06

(22) Date of filing: 17.06.92

(43) Date of publication of application:
05.01.94 Bulletin 94/01

(84) Designated Contracting States:
AT BE CH DE DK ES FR GB GR IT LI LU MC NL PT SE

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(54) Wave-breaking barrier for dissipating the energy of incoming waves near coasts.

(57) A wave-breaking barrier for dissipating the energy of incoming waves near sea shores or the like. The barrier is made up of modular supports (1, 1a) to which longitudinal elements in the form of girders (9) are fixed transversely to form a first inclined portion (5a) facing the open sea and simulating a sudden rise in the sea bed (6) which causes an initial breaking of the incoming wave and a second horizontal portion (4a) nearer the coast than the inclined portion (5a). This latter portion (4a) dissipates the energy of the wave.

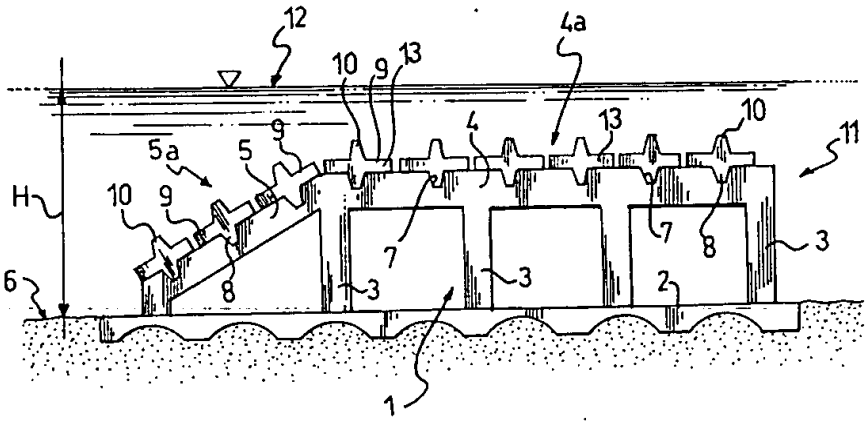

FIG.2

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The present invention relates to a wave-breaking barrier for dissipating the energy of incoming waves near sea shores or the like.

The invention provides a submerged artificial barrier able to damp and dissipate the energy of incoming waves through a process of fluid dynamics.

In the prior art, coastal defence, and particularly the defence of sandy coastlines, is carried out by placing blocks of limestone so as to form artificial reefs, at distances from the shore carefully chosen according to the pattern of the sea bed.

These reefs achieve the purpose of preventing the waves from eroding the coastline, but they have grave secondary effects on the environment of the stretch of water between the shoreline and the reefs themselves.

Drawbacks include the following:

- progressive silting up with sand and mud, and stagnation in the stretch of sea and seabed most important for bathing, spoils the attraction of the location and causes a health risk;
- a severe impact on the landscape;
- the obstruction of pleasure boats, including rowing boats, pedal boats or sailing boats, though only the smaller of these last;
- interaction between the reef and currents creates trenches in the sea bed causing danger to bathers.

The object of the present invention is to overcome the above drawbacks while obtaining the following advantages:

- to break only the larger waves, leaving the wave pattern undisturbed when waves are smaller than a level which can be set as required;
- to maintain currents parallel to the coast in order to allow the exchange of water in the stretch of sea between the reef and the sandy shore,
- to maintain a natural environment between the beach and the barrier, owing to the preservation of the dynamics of smaller waves, which are not stopped;
- to favour oxygenation, through the exchange of water, thereby preventing excessive mortality of benthic organisms as a result of local anoxia;
- to avoid any impact on the landscape or any obstruction to the small pleasure boats typically used off sandy beaches;
- to provide, thanks to the barrier's shape, an ideal environment for the growth and development of filtering bivalves and to attract and shelter fish, it being possible to give the barrier geometrical characteristics equivalent, from this point of view, to the artificial barriers of sea farming establishments;
- to be highly adaptable, even once installed, so that the barrier's performance can be modified both according to the wave pattern and according to the dynamics of the local sea bed;
- to be installable in repetitive modules which can be joined to form sections of various length, straight or otherwise, and to have a design adaptable to a wide range of sea depths;
- to be quickly installable, thanks to the use of prefabricated metal or concrete structures, and to be able to be repositioned;
- to be easy to inspect.

The object is achieved by the invention which provides the wave-breaking barrier characterised in Claim 1, which follows.

The invention will now be described in greater detail, with reference to the appended drawings which illustrate a few preferred non-limitative embodiments, in which:

Figure 1 is a schematic perspective view of a first embodiment of the barrier;

Figure 2 is a side view of the barrier of Figure 1,

Figure 3 is a schematic perspective view of a second embodiment of the barrier of the invention;

Figure 4 is an enlarged detail of Figure 3;

Figure 5 is a schematic side view of the barrier of Figure 3;

Figure 6 shows the same embodiment of the barrier as Figure 3 with the longitudinal curved slab elements in a second, different position;

Figure 7 shows the same embodiment of the barrier as Figure 3 with the longitudinal curved slab elements in a third position; and

Figure 8 shows the same embodiment of the barrier as Figure 3 with the longitudinal curved slab elements in a fourth position.

With reference to the above drawings, and in particular to Figure 1, the modular supports are generally indicated 1 and 1a. Each of these supports, in the structure shown in Figure 1, is made of concrete and each comprises a base 2, columns 3 and a horizontal element 4 joined to and supported by the columns 3.

The element 4, which extends longitudinally, is joined to an element 5 inclined towards the base 2.

In the embodiment shown in Figures 1 and 2, which is particularly adapted for construction in concrete and for use on substantially flat sea beds such as that indicated 6 in Figure 2, the elements 4 and 5 have slots 7 spaced along their length. These slots are provided for engagement by the ribs 8 of longitudinal elements 9 made as girders having a further longitudinal rib 10 opposite the rib 8 so that the element 9 is cross-shaped in section.

As shown in Figures 1 and 2, the longitudinal elements 9, when mounted on pairs of modular supports 1, 1a, constitute, with the latter, a section of artificial barrier for damping wave movement.

The inclined element 5 of the modular supports 1 and 1a is positioned towards the open sea while the opposite end 11 is facing the coast.

The dimensions of the barrier depend on the type of sea bed and on its depth from the sea surface 12 which can vary with the tides and drop to the level indicated 12a.

For example, the horizontal element 4 of the modular supports will be submerged at a depth varying between 0.5 and 1.5 metres from the sea surface 12.

It will be understood that, consequently, the structure will always be submerged in calm sea conditions.

The length of the horizontal element 4 and therefore of the horizontal length of the barrier may be around 2.5 times the depth H of the sea bed.

The inclined element 5, still by way of example, will be inclined at about 30-40 degrees to the horizontal.

The part of the barrier comprising the inclined elements 5 and the associated longitudinal elements or girders 9 forms an inclined plane 5a which simulates a raised sea bed 6 and causes waves rolling towards the shore to break early.

Along the element 4 the barrier forms a horizontal plane 4a which further breaks the wave, which is damped by the overall profile of the structure and in particular by the cross-sectional shape of the longitudinal elements 9 with ribs 10.

It is important to stress that the longitudinal elements or girders 9, though they are positioned close together, leave ample gaps 13 whose width can be chosen and predetermined by appropriate adjusting of the dimensions and positions of the said longitudinal elements 9.

The gaps 13 allow free circulation of currents between the barrier and the sea bed 6. In particular, the gaps 13 at the lower levels of the barrier draw water from the open sea beyond the lower end of the barrier towards the top of the barrier, thereby encouraging water exchange.

With reference to Figures 3, 4, and 5, which illustrate a second embodiment of the invention, it will be seen that the modular supports 1 and 1a consist respectively of metal frames comprising a front column 14, nearer the open sea, and a rear column 15 nearer the shore.

Both of the columns 14 and 15 are anchored to the sea bed 6 by respective foundations 16. The columns 14, 15 are linked at their tops by a horizontal element 17 running parallel to the free surface 12 of the sea.

The element 17, as in the embodiment previously described, is extended towards the open sea by an element 18 sloping towards the sea bed 6.

For construction reasons, the inclined element 18 is joined to the column 14 by a strut 19.

The structure, designed to be constructed in metal, includes a third horizontal element 20 parallel to the element 17. The said element 20 is joined to the columns 14, 15 by known means, for instance bolts 21 engaged in holes 22 therein.

Both the columns 14, 15 and the ends of the horizontal element 20 have holes 22 allowing for the location of the element 20 in several positions in relation to the section 17.

The longitudinal elements to be mounted across the modular supports 1, 1a, in the embodiment shown in Figures 3 and 4, consist of curved plates 23 whose longitudinal edges 24, 25 are rotatably coupled to the respective bars 26, 27 linked to the modular supports. More specifically, each bar 26 is connected to the elements 17 while each bar 27 is connected to the horizontal elements 20 by intermediate plates 28 fixed to the same element 20.

At the inclined element 18, on the other hand, both the bars 26, 27 for the curved plates 23 are connected to the one element 18 and it is therefore not possible to vary their positions.

If the connection to the columns 14, 15 of the horizontal element 20 is moved, one achieves different positions of the curved plates 23 as shown in Figures 5, 6 and 7 and therefore different dynamic damping effects on the waves hitting the barrier.

A different position of the connection between the plates 23 and the associated bars 26, 27 relative to the elements 17 and 20 makes it possible to obtain the configuration illustrated in Figure 8 in which the concavity of the plates 23 faces upwardly, that is towards the free surface 12 of the sea.

The anchorage of the structure to the sea bed 6 obviously depends on the nature and geotechnical characteristics of the sea bed itself. The invention can have further embodiments; however these are to be considered as falling within the scope of the present invention as claimed in the following claims.

Claims

1. A wave-breaking barrier for dissipating the energy of incoming waves near sea shores or the like, characterised in that it includes a plurality of modular supports (1, 1a) of predetermined longitudinal extent, fixed to the sea bed (6) near the shore with one end (11) facing the shore and the other end facing the open sea, the said supports (1, 1a) being positioned at

predetermined spacings alongside each other, and a plurality of longitudinal elements (9, 23) fixed transversely to the modular supports (1, 1a) and distributed along their longitudinal extents.

2. A wave-breaking barrier according to Claim 1, characterised in that each of the said modular supports (1, 1a) includes a first submerged element (4, 17) spaced from the sea bed (6) and extending parallel to the surface (12) of the sea and a second element (5, 18) also submerged, at the end facing the open sea and inclined towards the sea bed (6).

3. A barrier according to Claim 2, characterised in that the inclined second element (5, 18) is joined to the first element (4, 17) without any break in continuity.

4. A barrier according to Claim 1, characterised in that the said longitudinal elements are girders (9) with polygonal cross sections.

5. A barrier according to Claim 1, characterised in that the said longitudinal elements are girders (9) which are cross-shaped in section.

6. A barrier according to Claims 1 to 5, characterised in that the modular supports (1, 1a) and the longitudinal elements (9) fixed transversely thereto are made of concrete.

7. A barrier according to Claims 1 and 2, characterised in that each of the modular supports (1, 1a) includes a third submerged element (20) extending parallel to the first element (17), means (21, 22) being provided for positioning this third element (20) at predetermined distances from the first element (17).

8. A barrier according to Claims 1, 2 and 7, characterised in that the modular supports (1, 1a) and the longitudinal elements (23) fixed transversely thereto are made of metal.

9. A barrier according to Claim 8, characterised in that the said longitudinal elements are curved plates (23).

10. A barrier according to Claims 7 to 9, characterised in that the said longitudinal elements, in the form of curved plates (23), are provided with bars (26, 27) rotatably connected to the longitudinal edges (24, 25) of the plates, the bars (26, 27) being connected at their ends, one bar (26) to the first (17) and the other bar (27) to the third (20) of those elements of each modular support (1, 1a) which extend parallel to the surface (12) of the sea.

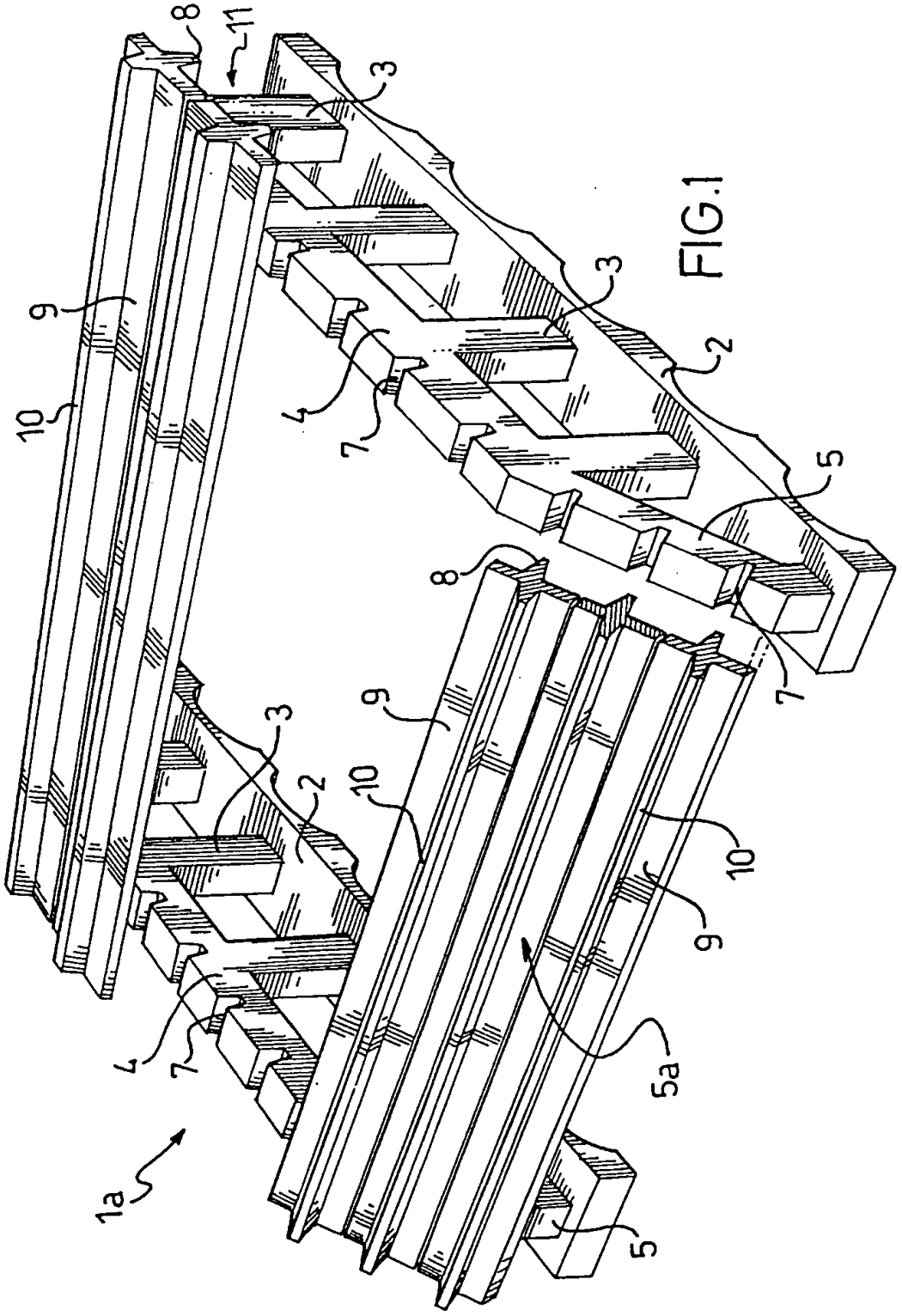

FIG.1

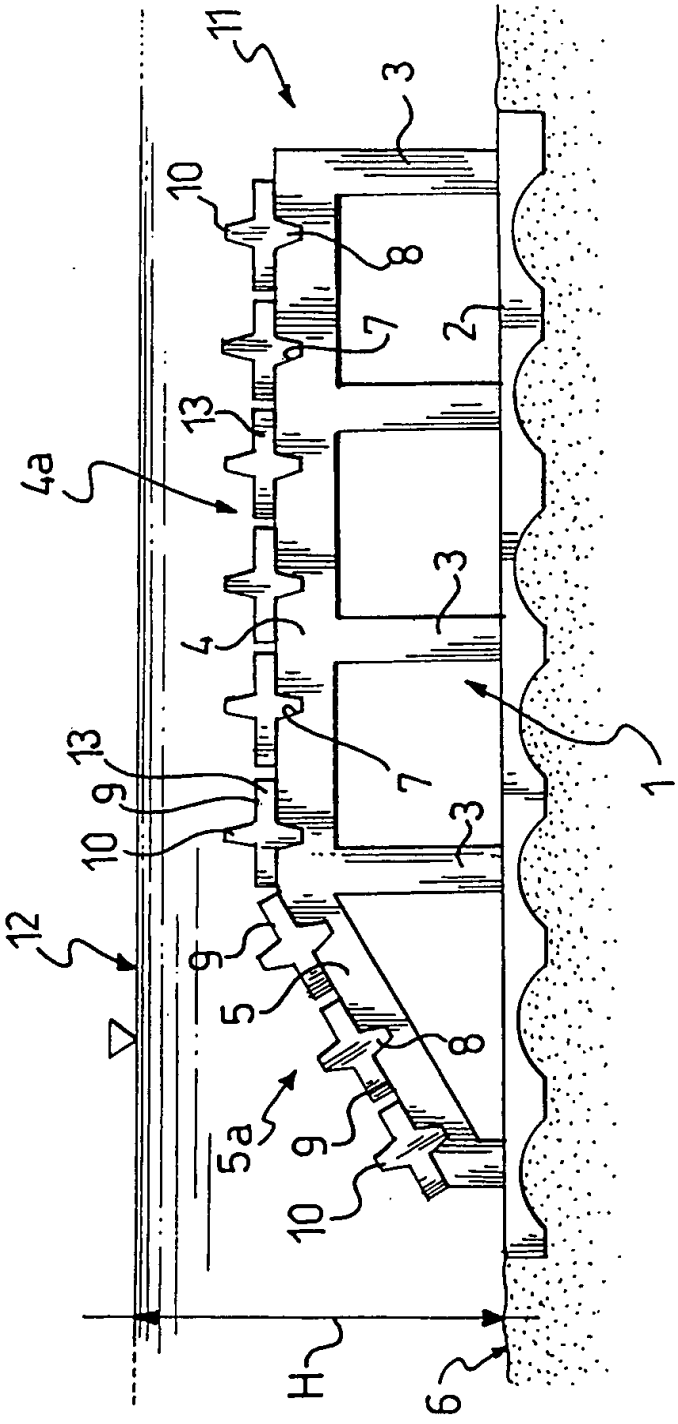

FIG.2

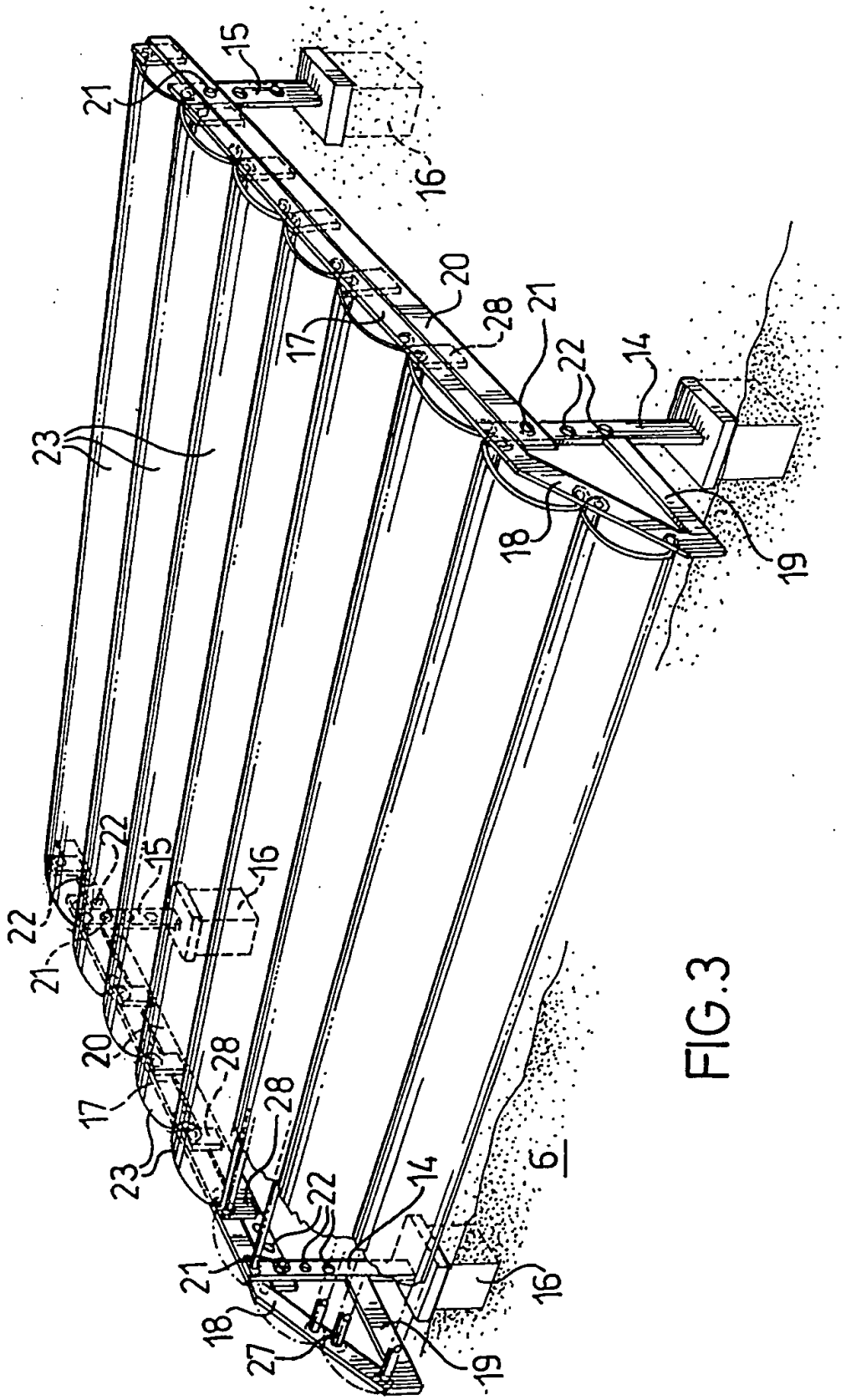
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FIG.3

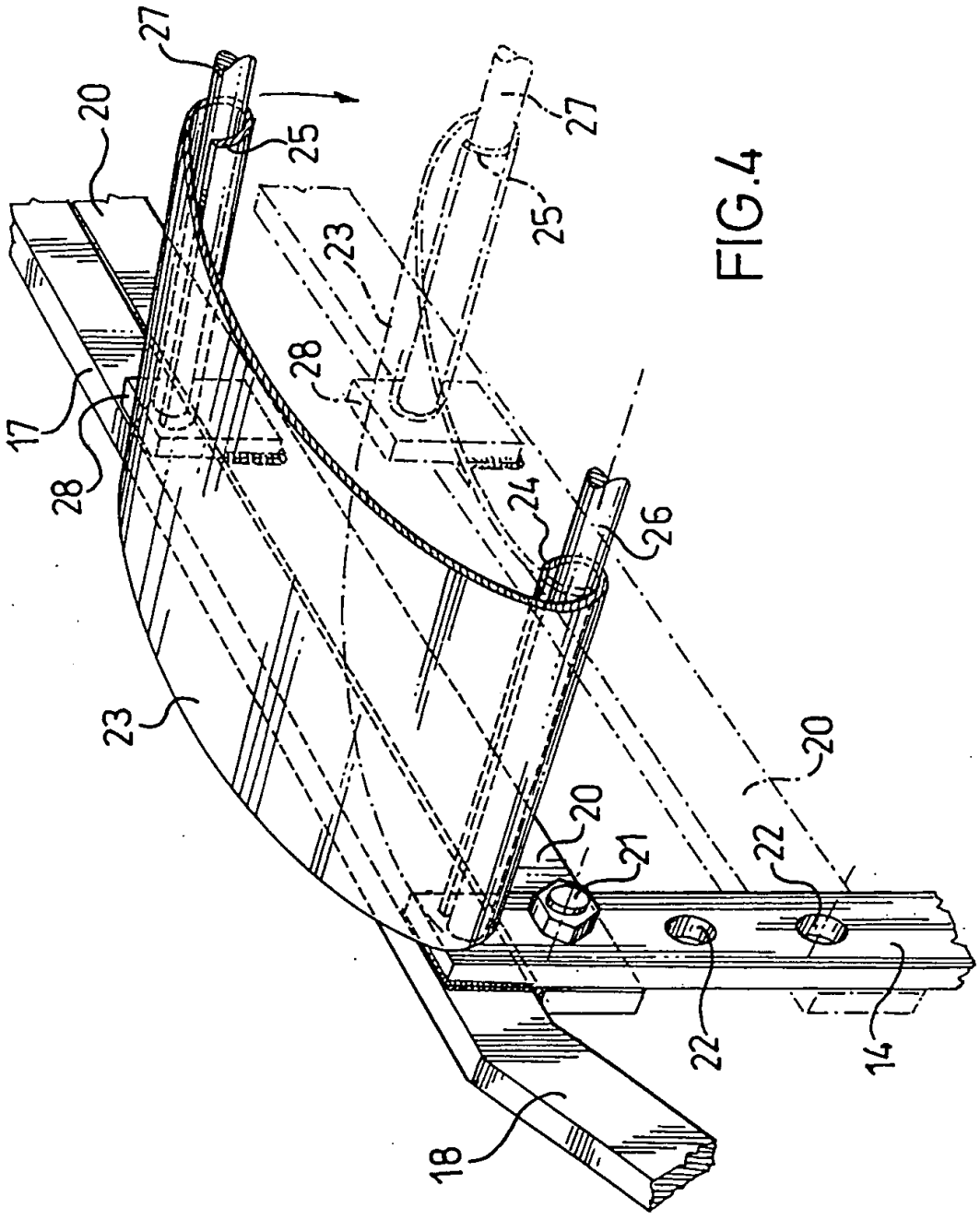

FIG.4

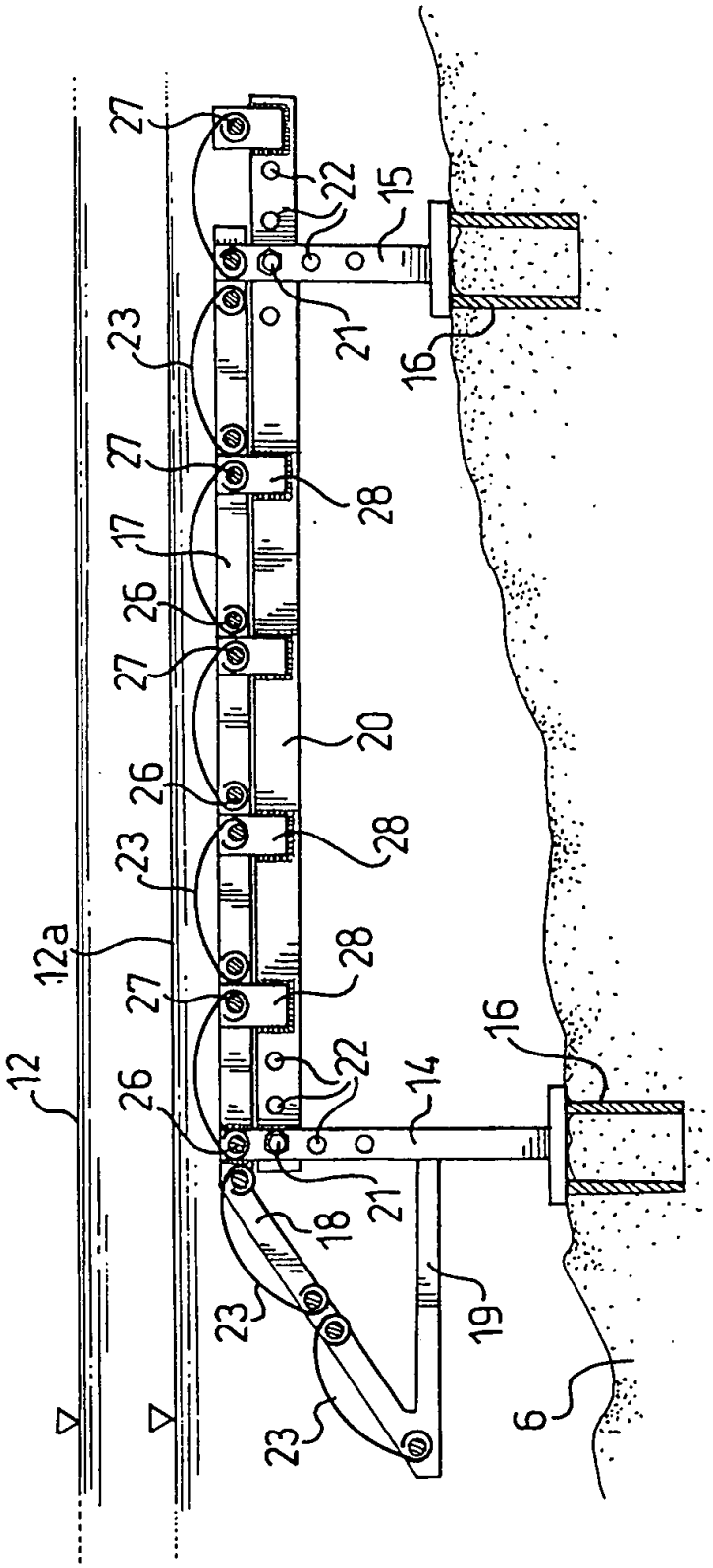
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FIG.5

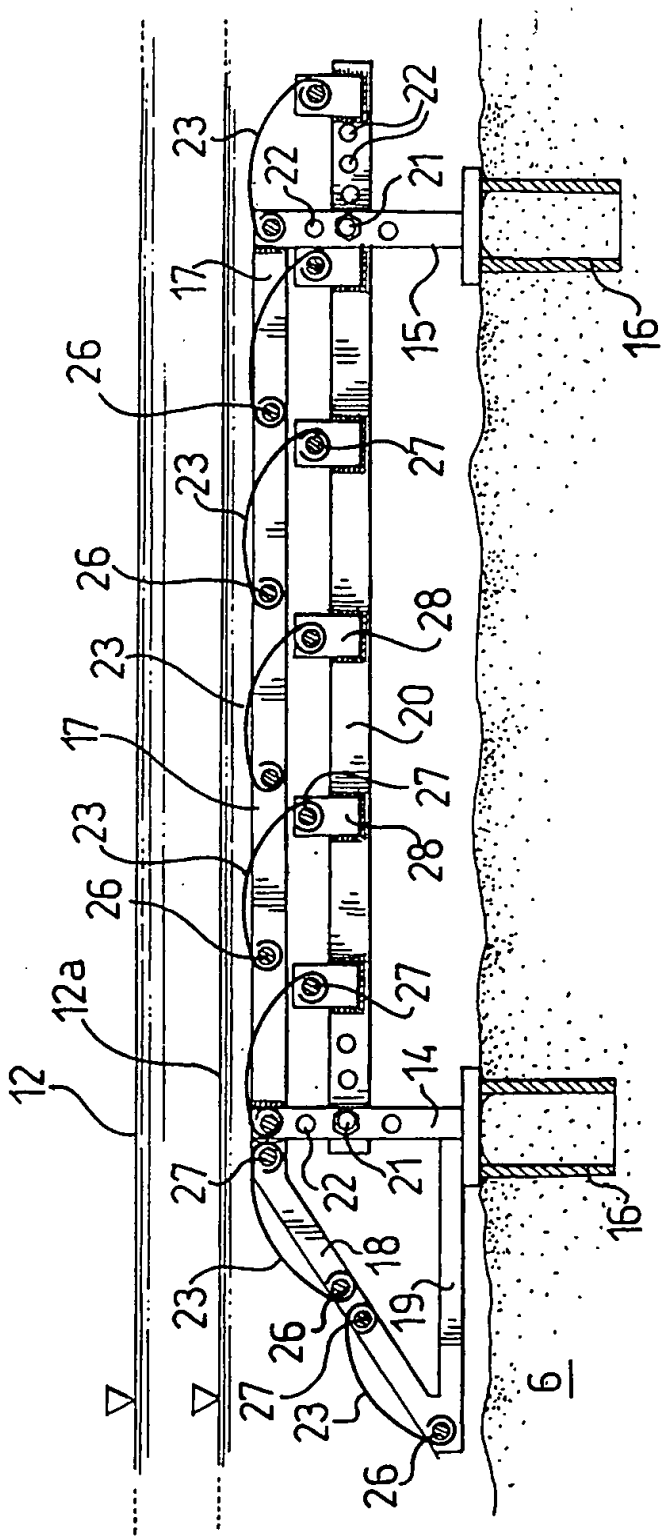

FIG.6

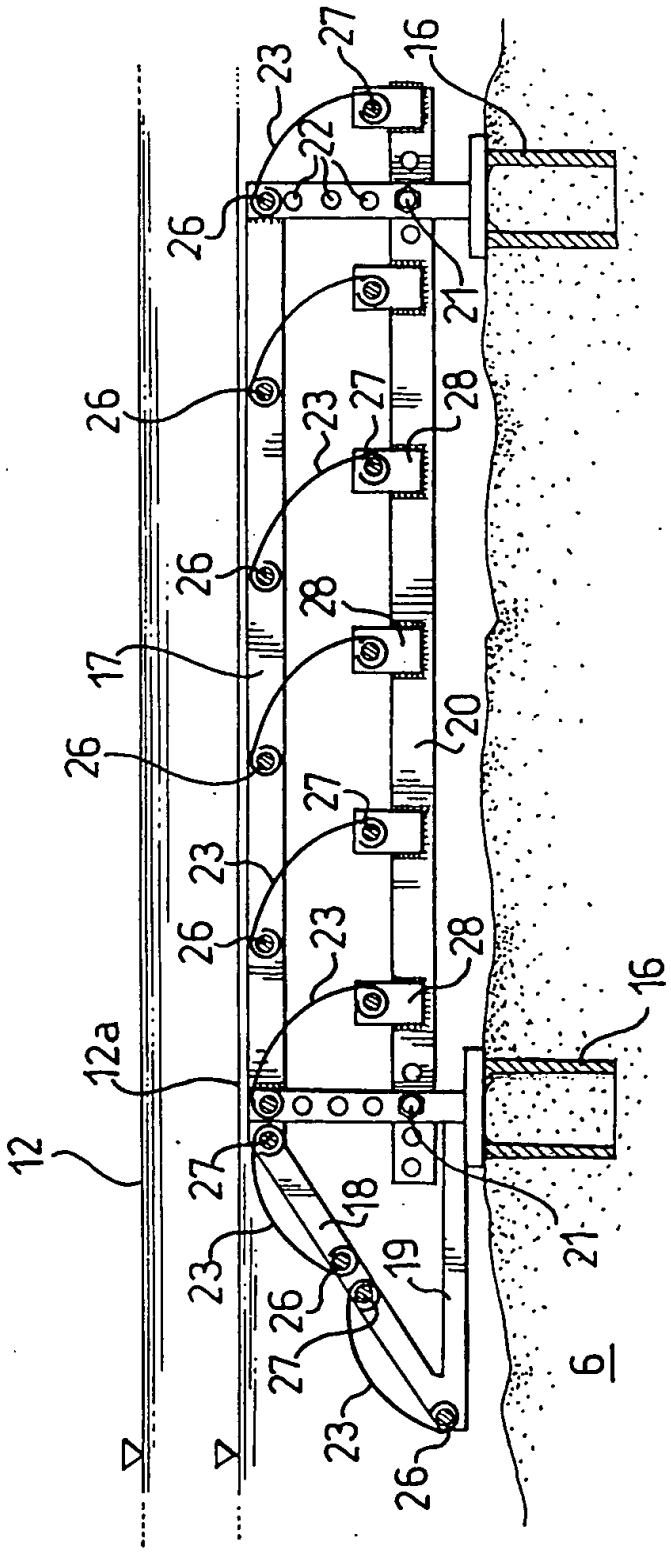

FIG.7

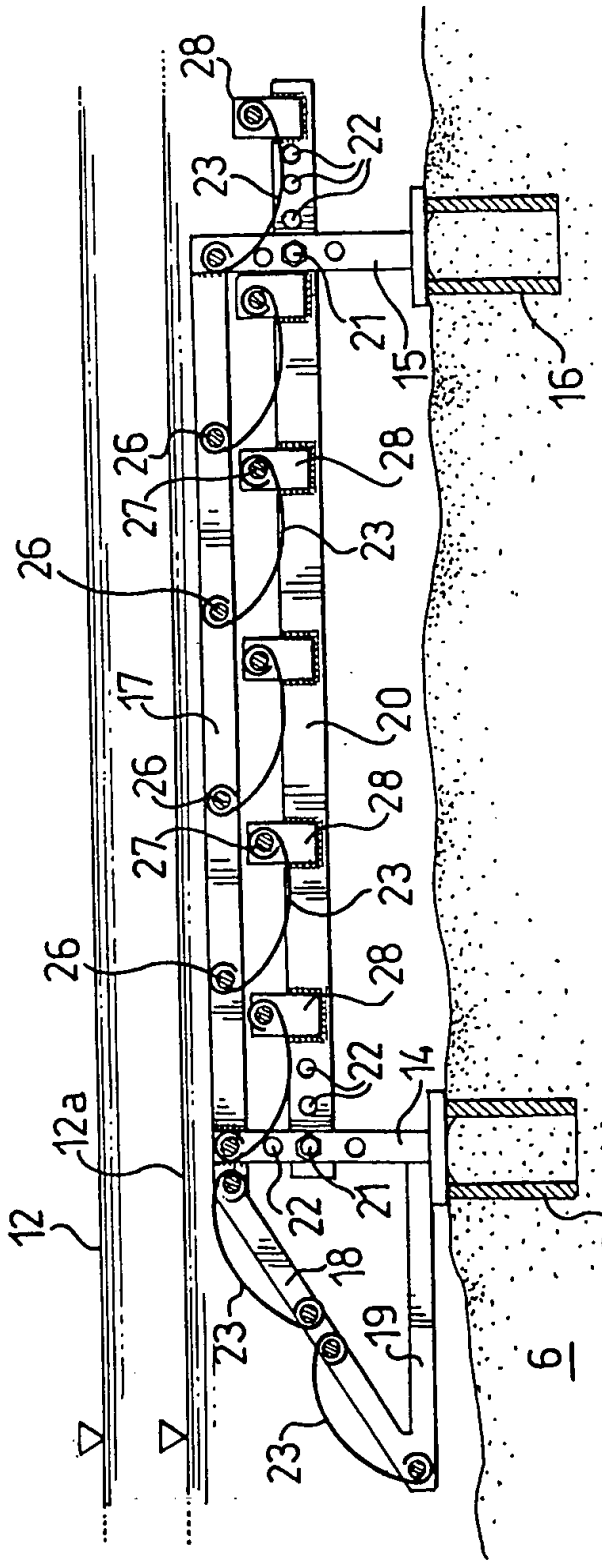

FIG.8

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EUROPEAN SEARCH REPORT

Application Number
EP 92 83 0321

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.5)
X A	US-A-3 845 630 (KARNAS) * column 2, line 33 - line 44; figures 1-3 * ---	1 2,8,9	E02B3/06
A	US-A-2 920 454 (WOLF) * column 2, line 40 - column 4, line 40; figure 4 * ---	1-3	
A	US-A-3 309 876 (POTTER) * column 1, last paragraph - column 2, line 29 * ---	1,2,7,8	
A	US-A-4 502 816 (CRETER ET AL) * abstract * ---	1,6	
A	FR-A-1 517 957 (PIOT) -----		

TECHNICAL FIELDS SEARCHED (Int. Cl.5)

E02B

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	16 FEBRUARY 1993	VAN BEURDEN J.J.C.A

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